1. (20 %) The block diagram of a feedback control system is shown in Fig. 1.
   (a) The controller with the transfer function $H(s)$ is for the reduction of the effect of the noise $N(s)$. Find $H(s)$ so that the output $Y(s)$ is totally independent of $N(s)$.
   (b) If the maximum overshoot of the unit-step input and the peak time are 20 % and 0.1 sec, respectively. Find the gains K_1 and K_2 when $H(s)$ is as determined in part (a).

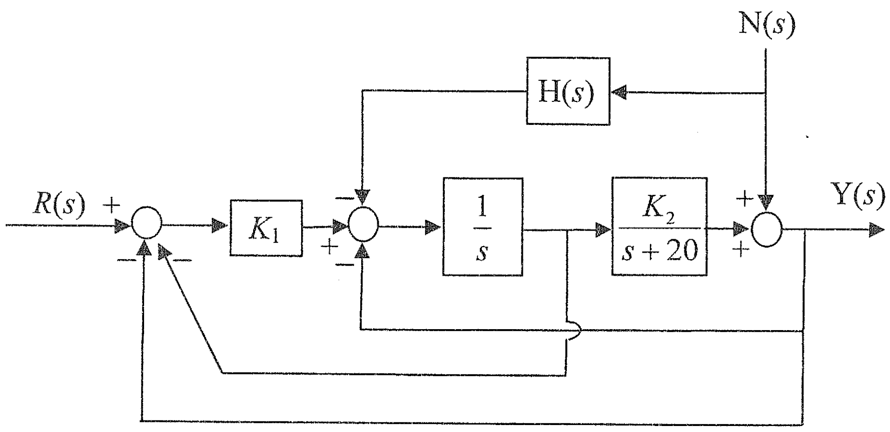

Fig. 1

2. (30 %) The transfer function of a unity feedback control system is

$$G(s)=\frac{K}{s(s+5)(s+10)}$$

   (a) Construct the root loci for $K \geqq 0$.
   (b) Using the Nyquist criterion, determine the range of K such that the closed-loop system is stable.
   (c) Find the value of K so that the gain margin of the system is 20 dB.

3. (20 %) Given the system of Fig. 2, with

$$G_p(s)=\frac{1}{s(s+5)^2} \quad \text{and} \quad G_c(s)=K\frac{1+\alpha Ts}{1+Ts}.$$

Design the phase-lag compensator $G_c(s)$ for the system such that the steady state error to unit ramp input is less than 10% and the phase margin is greater than 70°.

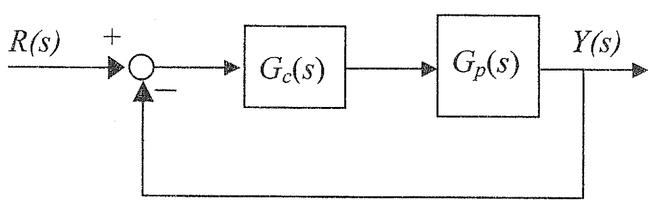

Fig. 2

4. (30 %) Fig. 3 shows an RLC circuit.

(a) Find the state equation for the circuit when $v(t)$ is an input, $i(t)$ is an output, and capacitor voltage and the inductor current are the state variables.

(b) Find the condition that the system is controllable and observable.

(c) Find the state-transition matrix $\phi(t)$ and the characteristic equation for the system.

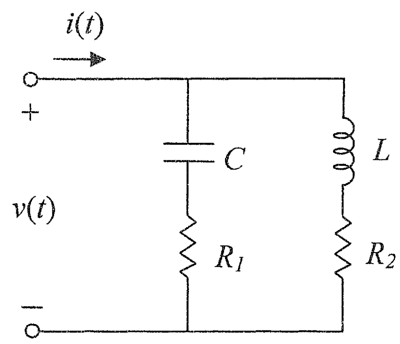

Fig. 3